Deliverable 4.1

General Discussions Sum-up

WP4: Synthesis

Project Name	OASIM	
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Written by	Camille SAVARY	UTAC
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Reviewers	Léo CORNEC	UTAC
	Thomas WIMMER	4A
	Jaruwan GULYANAMITTA	TDEM
	Xavier GROULT	VALEO
	Work Package 4 members	OASIM Partners
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Executive Summary

The OASIM project aims to improve the safety of the motorcyclists in the ASEAN countries by establishing active safety test protocols representative of the accident situations in this region. Work Package 4 is dedicated to draw-up the synthesis of the project, gathering the main results and discussions within the OASIM consortium. The main outcomes of each Work Package (WP) have been reviewed to build-up the final OASIM proposal for the next ASEAN NCAP Motorcyclist Safety Assessment in 2026 and prepare its dissemination (WP5).

This report describes the organisation of the project and the approach that was followed from September 2020 to December 2022. It also gathers the principal results and explanations to understand the elements of the proposal from the real accident cases to the setup of the test scenarios on the track.

In conclusion, the final test matrix of the relevant test scenarios to be integrated to the Assessment in 2026 has been established as below:

	CMRm		CMFtap	CMCrossing	CMOncoming
Paragraph	8.3.1		8.2.2	8.2.3	8.2.6
Type of test	AEB	FCW	AEB	AEB	LSS
VUT Speed [km/h]	40-60	40-80	(2026) 10,20	20-60	72
VUT direction	Forward		Farside turn	Farside and nearside	Farside
Target speed [km/h]	30,45,60		30,45,60	20	60
Impact location [%VUT width]	50	50 and 25	50	50 -50% motorcycle length	10
Lighting condition	Day		Day	Day	Day
Number of test	36 speed combinations (best case: 22 tests)		6 tests	9 speed combinations (best case: 5 tests)	4 – 5 tests

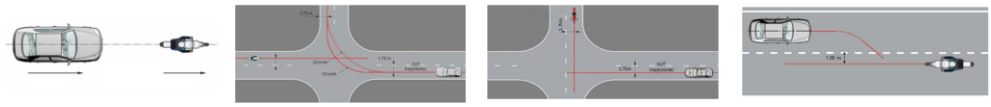

Figure 1: Final OASIM proposal for Motorcyclist Safety Assessment test scenarios for 2026

This proposal is also completed by recommendation for the ASEAN NCAP Motorcyclist Safety Assessment roadmap after 2026, with an expected feasibility to address the accident situation through ADAS systems.

The project has based this proposal on a detailed accident analysis and testing experiences. A literature review of the accidents involving the motorcyclist within the ASEAN countries has highlighted the lack of reliable and detailed data for some ASEAN countries. Two databases from Malaysia and Thailand have been studied to get the accidents parameters.

A motorcyclist target has been developed to reproduce the accident situation on the test track to assess ADAS systems efficiency. Based on the most sold motorcycles in the ASEAN countries and average adult rider dimensions, the dummy has been manufactured to get the required characteristics to be representative from the sensors point of view.

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Introduction

With 43% of fatalities among their road users, the South-East Asian countries have the highest rate of death among riders of motorized 2- and 3-wheelers (according to the Global Status report on Road Safety 2018). The Association of Southeast Asian Nations (ASEAN), an intergovernmental organization created in 1967, represents ten countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

With pedestrians and cyclists, motorcyclists are considered as Vulnerable Road Users (VRU) as they respectively account for 26% (pedestrians and cyclists) and 28% (motorcycles) of all deaths in the world. Looking at the ASEAN countries situations, their proportion goes up to 59% of the fatalities on the road.

Since 2011, the ASEAN New Car Assessment Program (ASEAN NCAP) aims to elevate vehicle's safety standards. ASEAN NCAP places high importance on motorcyclist safety and claim to become the most challenging protocol of a kind. Thus, the Motorcyclist Safety Pillar was specifically created in the 2021-2025 Roadmap, to urge the automotive industry to reduce motorcyclist's road traffic deaths through new technologies. The industrial consortium Overall ASEAN market Safety Improvement for Motorcycles (OASIM) coordinated by UTAC was set off in September 2020 with the support of the ASEAN NCAP. The OASIM project aims to improve the motorcyclist safety in the ASEAN region by promoting an official rating.

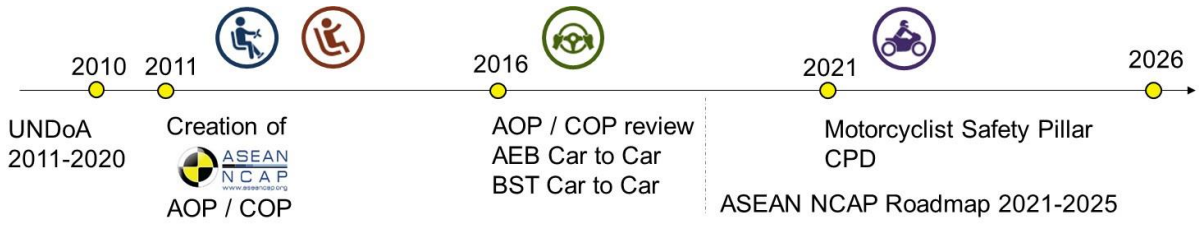


Figure 2: ASEAN NCAP from 2011 to 2026

The fourth Work Package (WP4) aims at providing a summary of the results leading to clear proposal for the next update of the ASEAN NCAP Motorcyclist Safety Assessment in 2026. The proposal is based on the accident analysis between a passenger car and a motorcycle in the ASEAN region. The twelve main accidents have been studied in detailed to sort out the most relevant and feasible test scenarios, addressable by ADAS systems. The study of the databases gave the information necessary to set up the parameters of the test scenarios to reproduce these accidents. The objective is to develop the tools to evaluate these systems.

In order to carry out the test scenarios, it was also necessary to develop a motorcyclist target with the main characteristics to be representative of the real motorcycle and be impactable, with an acceptable duration of use.

First, this report reminds the context of the road fatalities with a focus on the motorcyclist's safety to highlight the challenges of projects, such as OASIM. It describes the framework and organisation of the project to lead through the work to achieve the objectives. Finally, a sum-up of the main outcomes of the accident data study (WP1), the motorcyclist target development (WP2) and the definition of a test and assessment protocol (WP3) is described in this report. The end of the documents states on the dissemination expected to share the OASIM proposal.

1 Glossary

OASIM	Overall ASEAN market Safety Improvement for Motorcycles
ASEAN	The Association of Southeast Asian Nations
NCAP	New Car Assessment Programs
ASEAN NCAP	New Car Assessment Program for Southeast Asian Countries
Euro NCAP	European New Car Assessment Programme
ANCHOR	ASEAN NCAP Collaborative Holistic Research
ADAS	Advanced Driver Assistance systems
ARAS	Advanced Rider Assistance Systems
PTW	Powered-Two-Wheeler
VUT	Vehicle Under Test
AMT	ASEAN NCAP Motorcycle Target
AEB	Autonomous Emergency Braking
FCW	Forward Collision Warning
LSS	Lane Support System
LDW	Lane Departure Warning
LKA	Lane Keeping Assist
ELK	Emergency Lane Keeping
BST	Blind Spot Technology
BSI	Blind Spot Information
BSD	Blind Spot Detection
BSW	Blind Spot Warning
CMRm	Car-to-Motorcycle Rear-end moving scenario
CMFtap	Car-to-Motorcycle Front Turn Across Path scenario
CMCrossing	Car-to-Motorcycle Crossing scenario
CMOncoming	Car-to-Motorcycle Oncoming scenario
COP	Child Occupant Protection
CPD	Child Presence Detection
AOP	Adult Occupant Protection
TTC	Time to Collision
ISO	International Organization for Standardization
RHD	Right-Hand Drive
LHD	Left-Hand Drive
EPS	Electronic Power Steering system
ESC	Electronic Stability Control
WP	Work Package
WG	Working Group
WHO	World Health Organization
RRSS	ASEAN Regional Road Safety Strategy
UNDoA	United Nations Decade of Action on Road Safety
KSI	Killed or Seriously Injured

2 OASIM Project

2.1 Context

The Association of Southeast Asian Nations, or ASEAN, was established on 8 August 1967 in Bangkok, Thailand, with the signing of the ASEAN Declaration (Bangkok Declaration) by the Founding Fathers of ASEAN: Indonesia, Malaysia, Philippines, Singapore and Thailand. ASEAN accounts nowadays 10 countries with the additional ones Brunei Darussalam, Viet Nam, Lao PDR, Myanmar and Cambodia.

Based on the Global Status Report on Road Safety (WHO, 2018) [1], the data shows that the criticality to address the accident within the South-East Asian region which has the second highest rate of road traffic death.

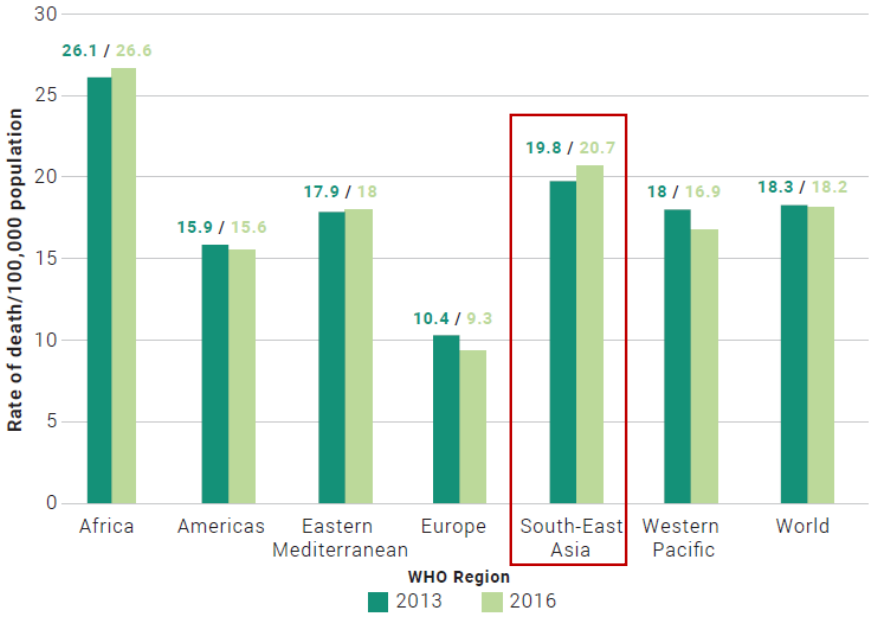


Figure 3: Rate of road traffic death per 100,000 population by WHO regions: 2013, 2016

Over the world observation, the data show that low- and middle-income countries bear the greatest burden of road traffic fatalities and injuries. The report also highlights that the risk is more than 3 times higher in low-income countries than in high-income countries.

More than half of all road traffic deaths are among vulnerable road users (VRU): pedestrians, cyclists and motorcyclists. Moreover, looking at the proportion within the type of road users, the motorcyclists are the most represented within South-East Asian countries with 43% of the death. This region is the one with the higher rate of fatalities among the motorized 2- and 3-wheelers. In part of the ASEAN countries, they even account for more that the half of the road death up to three quarter of the fatalities in some of them, such as Cambodia (73%), Thailand (74%) and Indonesia (74%). Motorcyclist safety is therefore one of the major road safety concerns in ASEAN region.

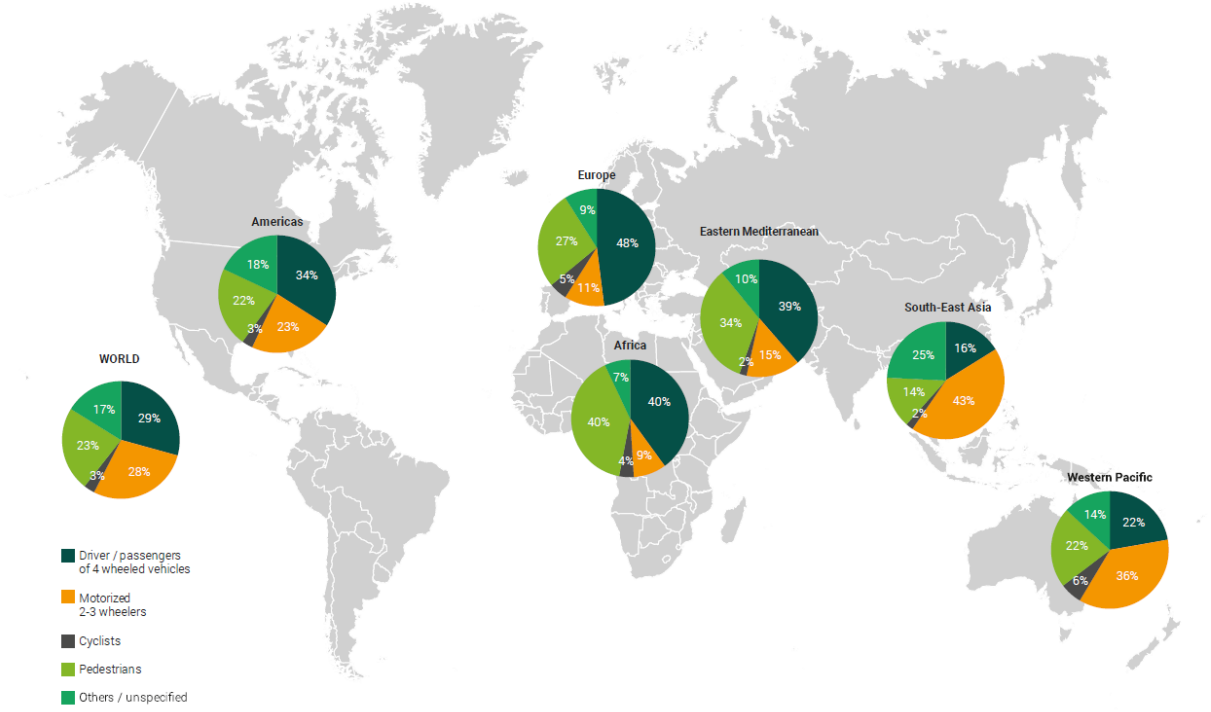


Figure 4: Distribution of death by road user type by WHO regions.

The report on the ASEAN Automotive Industry (Automotive World, 2018) [2] states the main facts about the status of the automotive industry, and the conclusions in overall and by countries is as follow.

ASEAN continues to strengthen ties between its economies. The elimination of tariffs on imported completely built-up (CBU) vehicles enables OEMs to treat the region as a single market. Vietnam shows a low vehicle ownership rate, however the car registration tends to increase, even more with the abolition of tariffs could make affordable cars available to its emerging middle class. However, OEMs remain concerned about non-tariff barriers in the region, and Vietnam presents a case in point; Decree 116, which went into effect at the start of 2018, places stringent testing requirements on all vehicle shipments.
Thailand, the region's biggest manufacturer, wants to raise annual production to 3.5 million units by 2025. It hopes a comprehensive set of incentives will attract further investment. Thailand faces competition from Indonesia, which has its own goal of becoming the leading production hub. Singapore has emerged as a hotbed for autonomous testing. Companies like Aptiv-owned nuTonomy continue their trials, as the country moves towards a 'car-lite' society. The government plans to cap new vehicle growth at 0%. Countries in the bloc are laying favourable conditions for electrification. Thailand is planning tax exemptions for companies who want to manufacture EVs and EV components, and the Philippines will introduce excise duty exemptions for EVs and hybrids. Philippines remains an important location for the auto sector. Sales in 2017 were up 17%, and the country has ambitions of becoming a manufacturing hub capable of producing 1 million units a year by 2027.

Japanese OEMs continue to dominate the market. Chinese OEMs begin to emerge however still lack the ASEAN production base which Japanese OEMs have established through the decades.

The ASEAN region shows a specific traffic situation by the presence of a high proportion of motorcyclist within their roads users, bringing new challenges to the integration of ADAS system and a specific traffic situation to take into account. The following figure describe the proportion of each type of vehicle in the fleet (all registered vehicle within a year) of the ASEAN countries. Data were provided by (WHO, 2018) for all countries except Indonesia and Viet Nam (ASEAN, 2016). Data concern 2016 numbers observation. [3]

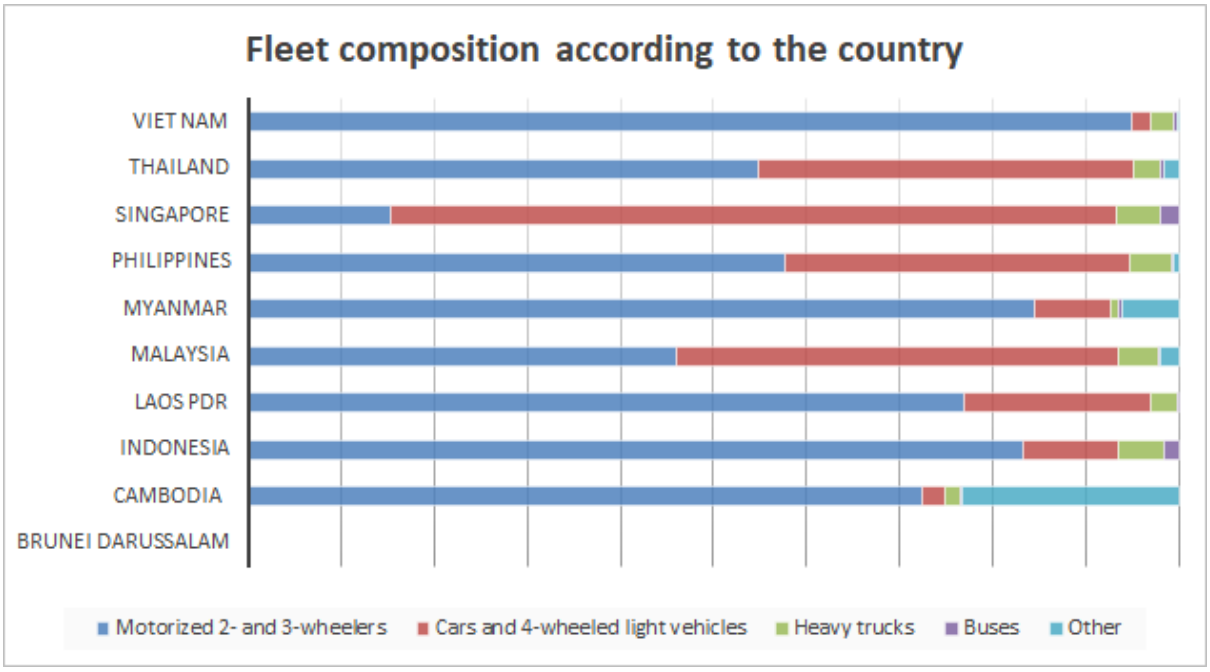


Figure 5: Fleet composition by road users categories with the ASEAN countries.

The graph highlights the high proportion of motorcycles in The Association of Southeast Asian Nations (ASEAN) countries vehicle fleet. Even in Malaysia which has one of the lowest percentages of ASEAN countries, PTWs constitute nearly a half of the vehicle registered in the country.

Then, as the Figure 3 already shows in comparison to the other parts of the world, for the ASEAN region, the percentage of PTWs users among the death of the road users is also high as highlighted in Figure 6.It is particularly important in Laos PDR, Thailand, Cambodia and in Malaysia with more than two-third of the road death.

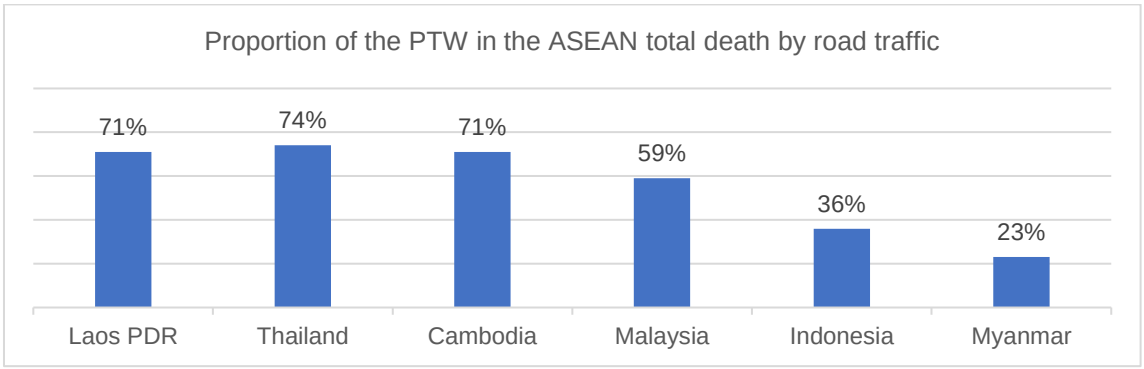


Figure 6: Graph based on the report of the ASEAN Regional Road Safety Strategy - Jakarta, ASEAN Secretariat, October 2016

After this conclusion the important road traffic death rate, strategic directions have been implemented by the ASEAN Regional Road Safety Strategy (RRSS). Within that context ASEAN NCAP have been promoting road safety through car safety assessment and focused within the last few years on motorcyclists.

From the 90's, institutions all around the world have been established to promote road safety making it mandatory within the car development and not optional. Therefore, ASEAN NCAP was created in 2011 in response to the United Nations' Decade of Action for Road Safety 2011-2020. The UNDoA is split into 5 pillars: road safety management, safer road and mobility, safer vehicles, safer road users and post-crash response. One of the existing aims of the third pillar – safer vehicles – is passive safety. To reduce road traffic deaths, it would be now important to work on how to reduce the number of those accidents. Therefore, it is necessary to focus on this goal by working on the benefits of active safety.

The ASEAN NCAP Assessment has been updated through the years accordingly.

From 2011 to 2016, the focus of the first achievements was to urge the industry to improve the passive safety level in the cars. Then almost every passenger car in ASEAN equipped with Airbags, as minimum front seatbelt reminder. There have been major changes within the automotive ecosystem with the safety no longer as optional. However, the price is still important, and the safety has to be affordable.

From 2017 to 2020, the passive safety has been continuing with the promotion of the airbags and the revision of the Child Occupant Protection requirements to fit the ASEAN region values and the utilization of Q dummies. Active Safety was also introduced with the integration of Autonomous Emergency Braking (AEB) in the market, including AEB Interurban specification. ASEAN NCAP also introduce Blind Spot Technology (BST) in the assessment. Blind Spot Technology i.e. Detection or Visualization has been added in passenger car. Furthermore, ESC is also a technology that has been pushed and has been then integrated as standards fitment in almost each car.

ASEAN NCAP 2021-2025

AOP		COP		Safety Assist		Motorcyclist Safety	
Item	Max	Item	Max	Item	Max	Item	Max
Frontal	16	Frontal	16	*EBA*	6	*BSD / BSV*	8
Side	8	Side	8	*SBR(Fr.)*	3	*Rear View Technology*	4
HPT Evaluation	8	CRS Installation	12	*SBR(Rr.)*	1.5	*AHB*	2
		Vehicle Based Assessment	13	*SBR(Rr.) Advanced*	1.5	Pedestrian Protection	2
		Child Presence Detection	2	*AEB City*	2.5		
				AEB Inter Urban	3.5	*[Advanced MST]**	2*
				Advanced SAT	3	**BONUS POINT*	
Score	32		51		21		16
Weighting	40%		20%		20%		20%

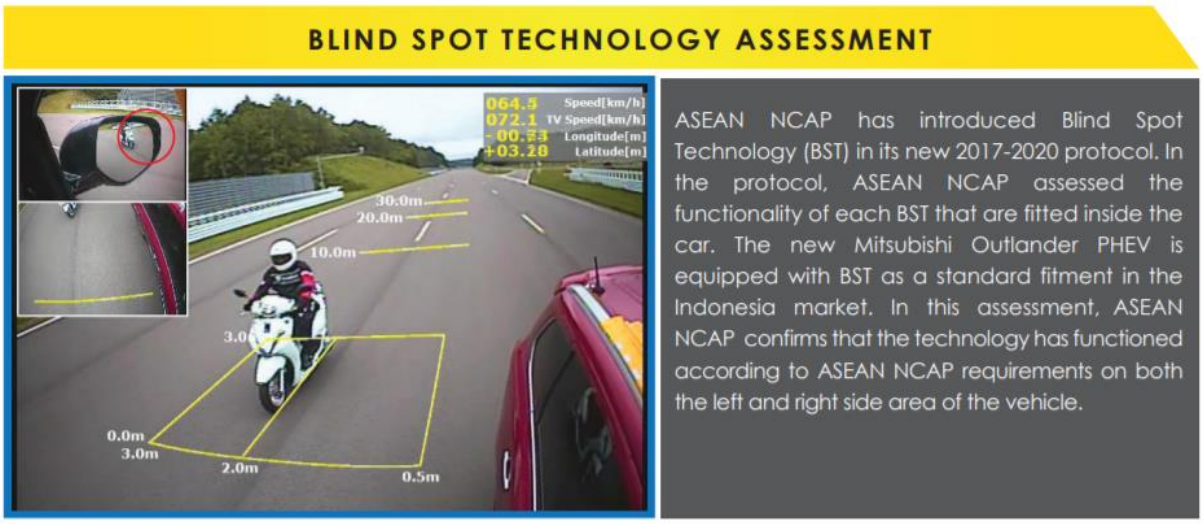
Slanting = Fitment Rating System

** To add 2 points MAX to total MS point*

	AOP (%)	COP (%)	Safety Assist (%)	Motorcyclist Safety (%)
5 ★	80	75	70	50
4 ★	70	60	50	40
3 ★	60	30	40	30
2 ★	50	25	30	20
1 ★	40	15	20	10

Figure 7: ASEAN NCAP Assessment 2021-2025.

For the program 2021-2025 [4], ASEAN NCAP created new pillar called Motorcyclist Safety Pillar. Currently, combining Safety Assist equipment that would be able to save motorcyclist lives i.e. Blind Spot Technology, Auto High Beam, Intelligent Rear View Mirror etc. Additionally, COP requirement were enhanced with Child Presence Detection (CPD). The new protocols are now developed under ANCHOR II Project [5].



For 2026 [6], the expectation is that the Motorcyclist Safety Pillar will have promoted the Blind Spot Technology (BST) as most of the new vehicles sold will be equipped with the system. The main technologies included in BST are Blind Spot Detection (for 5-star level), Blind Spot Visualization (for 5-star level) - Blind Spot Visualization i.e. Lane Watch Technology It is supported by Rear View Enhancement Technology i.e. Intelligent Rear View Mirror. It is also expected that more high-level Lighting system which will recognize Motorcycle more effectively. Pedestrian Protection based on UN Regulation 127 or GTR 9 is added into this pillar as part of VRU.

Therefore, within that context the expectation is that OASIM Project will help ASEAN to reduce motorcyclist fatal accidents in the future.

2.2 OASIM

Following those observation and the expectations, it is necessary to focus on this goal by working on the benefits of active safety. As shown in the previous paragraph PTW fleets and their proportion in the total death road in Southeast Asian region, safety for motorcyclist represents a major issue. ASEAN NCAP urges now the automotive industry to reduce PTW road traffic death through new technologies.

In this context, ASEAN NCAP has launched this consortium “Overall ASEAN market Safety Improvement for motorcycles” (hereinafter “Consortium”). UTAC is assigned to manage the Consortium for ADAS improvement adapted to the motorcycle safety, aiming to develop a motorcyclist safety assessment in the name of ASEAN NCAP. Indeed, ASEAN NCAP places high importance on motorcyclist safety and it aims to become the most challenging protocol of a kind. Finally, testing protocols involving motorcyclists shall be integrated into the ASEAN NCAP Guidelines beyond the Roadmap 2021 – 2025.

The main objective of the Consortium is to improve the motorcyclist safety:

- by studying main accident scenarios and possible systems that could help to avoid them or at least reduce their consequences
- by developing the tools to improve and evaluate the performances of these systems

To achieve the above-mentioned strategic objective, the following specific objectives are defined:

O1. Compilation of accident data from Southeast Asian region and identification of the main scenarios and parameters

One of the first objectives of this project, has been to gather accident databases from the Southeast Asian region and combine them into a common structure. The information from the different databases have been compiled to draw conclusions about the most common situations. Furthermore, the characteristics of these accidents have been identified though selected key variables that define them. Some existing studies about passenger’s car and motorcycles accidents have also been added to the literature review study.

O2. Development of a Motorcyclist Target

In order to be able to evaluate the performances of the different vehicle sensors and systems, it is necessary to get adequate test equipment, dummy and propulsion system. The most representative ASEAN-region-road-traffic motorcycles has been characterized based on information from the accident databases and from a market study. Then a compilation with

existing targets characteristics enabled to define the specifications for a new visual and radar-signature-requirements-compliant ASEAN motorcyclist target.

O3. Defining a Test and an Assessment Protocol

To achieve this objective, the main accident scenarios identified in O1 to be addressed by ADAS systems has to be reproduced on the track to evaluate the systems. The results have been compared with other NCAPs. A test protocol and an assessment protocol has been defined to evaluate any advanced assist systems applied to the ASIAN region.

O4. Summarising the results

The results have been summarized in order to build-up the OASIM proposal based on the discussions within the consortium. This objective will help to insert those test protocols and procedures into ASEAN NCAP assessment for vehicle active safety features, by clear explanation of the results within the project.

O5. Dissemination of the results

All the results of the project will be disseminated within other NCAPs, regulatory forces, standards institutions and industry.

To meet these objectives the automotive industry and ADAS testing experts have been gathered within the project Industry involved within the project.

The following car manufacturers and automotive suppliers participated in the project:

- Valeo Comfort and Driving Assistance SAS
- Toyota Daihatsu Engineering and Manufacturing Co., Ltd.
- Nissan Motor Asia Pacific Co.Ltd
- Daihatsu Motor Co., Ltd.
- Honda R&D Co., Ltd.
- Mitsubishi Motors Corporation
- DENSO Automotive Deutschland GmbH
- Hitachi Automotive Systems, Ltd.

The project was supervised by ASEAN NCAP and led by UTAC, also representative of testing expert as recognized test laboratory:

As development partner, 4activeSystems was involved in the project with the main focus on the target development and manufacturing:

CEESAR, as European Center for Security Studies and Risk Analysis was the subcontractor in charge of the accident data study.

MIROS, as the Malaysian Institute of Road Safety Research, was involved in the project as provider of the Malaysian national database and host of the workshops in Malaysia. The institute is also an official test laboratory for ASEAN NCAP assessments.

Yamaha is involved as provider of the in-depth Thai database with HONDA, and motorcycle manufacturer.

2.3 Project organisation

To deal with the main objectives to achieve, the tasks have been defined in five Work Packages.

WP #	WP Title
WP0	Project Management and Coordination
WP1	Accident Data Study
WP2	Development of a Motorcyclist Target
WP3	Defining a Test and an Assessment Protocol
WP4	Synthesis of the Project
WP5	Dissemination

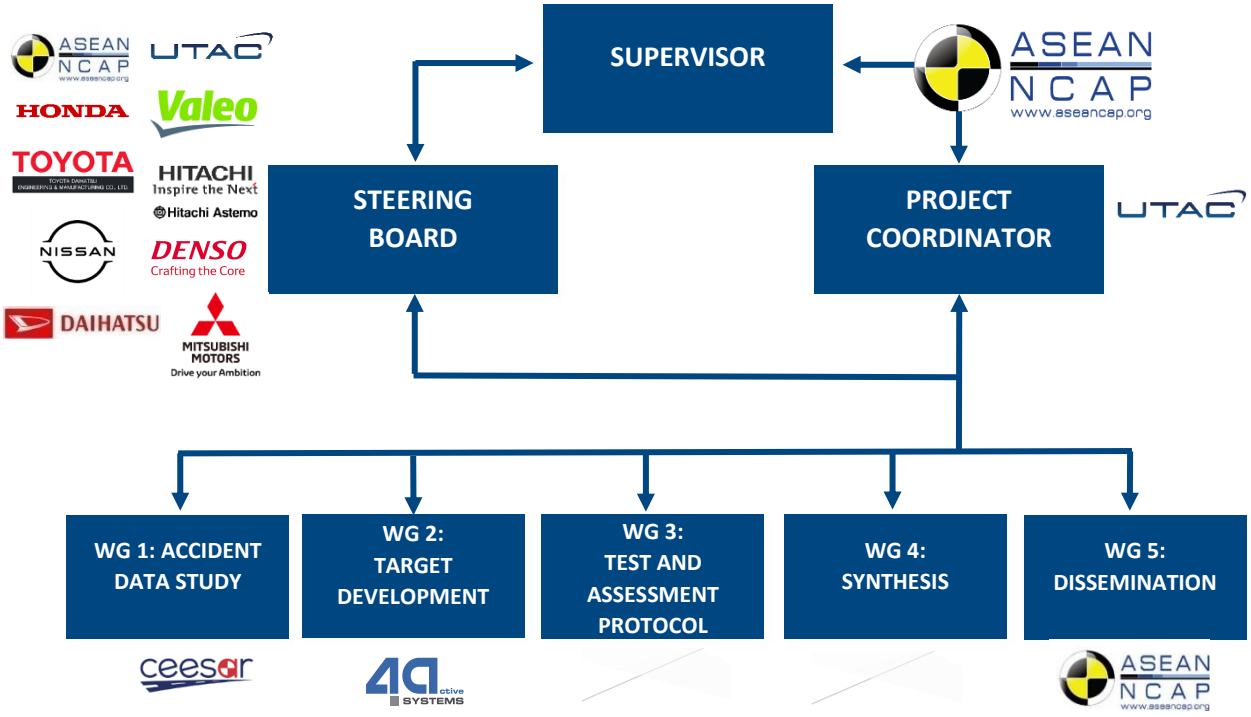


Figure 8: OASIM project organisation scheme.

WP1 Accident data study

- Objectives:
  - Identify the type of accidents in which motorcyclists are involved
  - Describe the accidents situations to provide information for WP3
- Tasks:
  - Perform a literature review on the ASEAN region road context, and the accidents scenarios involving the motorcyclists.
  - Collect data information and databases from the ASEAN countries.
  - Define a methodology adapted to the database to compile the informations and identify the most relevant accident scenarios.
  - Describe the relevant parameters for the selected scenarios
- Deliverables:
  - D1.1 – Accident scenarios description
  - D1.2 – Accident parameters description for the chosen scenarios

WP2 Development of a motorcyclist target

- Objectives:
  - Develop a target which fits the detection characteristics of a real motorcycle, based on the most representatives of ASEAN powered-two-wheeled fleet.
  - Check the performance of the dummy developed with the propulsion systems solutions (with existing platform) on the market.

- Tasks:
  - Characterize the ASEAN region motorcycles and their riders to define the dummy aspects and dimensions.
  - Develop and improve the target properties to fit the requirements in terms of detection (by RADAR, NIR, lidar,…) and with the necessary robustness for testing.

- Evaluate the existing propulsion systems solutions

- Deliverables:
  - D2.1 – Target Technical specifications

WP3 Test and Assessment Protocol

- Objectives:
  - Define a Test and Assessment Protocol to allow the evaluation of the systems in the uses cases identified in WP1
- Tasks:
  - Define the most relevant accident scenarios to be addressed by ADAS and for the test development
  - Review the NCAPs that deals with PTW accidents, and the methods used.
  - Define the variables to define the test scenarios regarding the WP1 results.

- Deliverables:
  - D3.1 – Test and assessment protocol

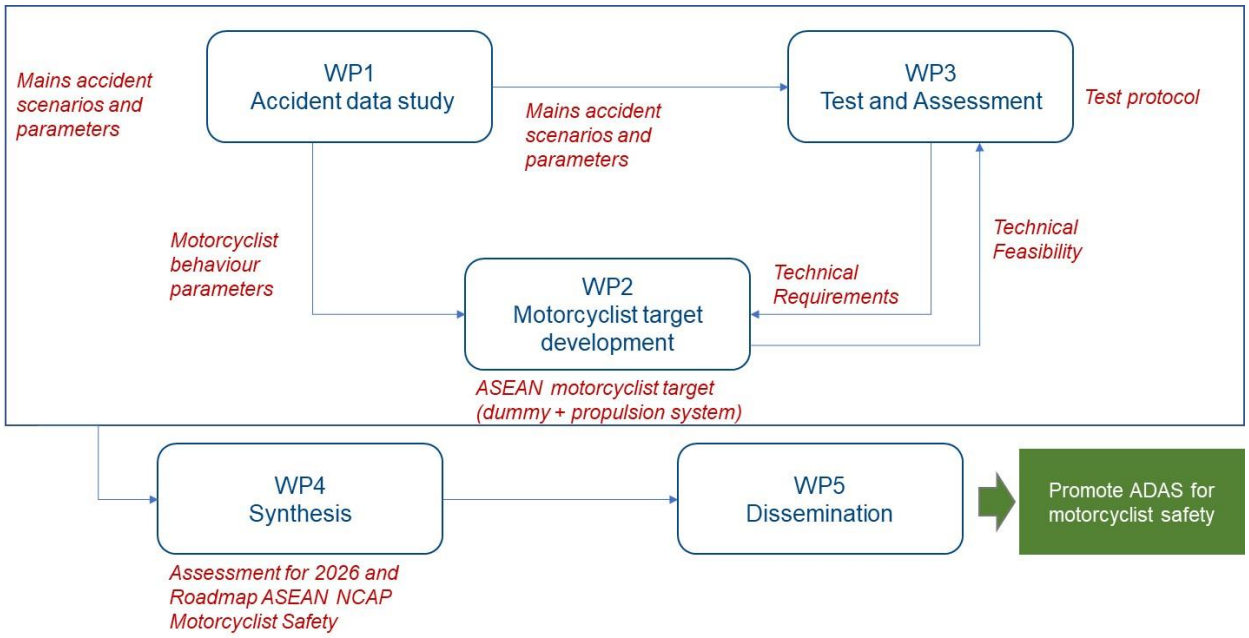
WP4 Synthesis

- Objectives: Summarize and review the main results of the OASIM project.
- Tasks:
  - Review the deliverables from WP1, WP2, WP3.
  - Build-up the conclusion leading to the clear presentation of the OASIM proposal for ASEAN NCAP Motorcyclist Safety Assessment 2026.
- Deliverables:
  - D4.1 General Discussions sum-up

WP5 Dissemination

- Objectives: Disseminating all the results of the project within other NCAPs, regulatory forces, standards institutions and industry
- Tasks:
  - Disseminating the results of the Project to other NCAPs, regulatory forces, standards institutions and industry to give guidelines to enrich other testing roadmap.

The Work Packages are organized together to coordinate the information and provide the inputs necessary to each work package.



Red font = data flow of information between the WP.

Figure 9: Work Packages organisation and information linked in-between.

3 Synthesis of the results

3.1 Accident data study

The first step within the accident data study is to perform a literature review on the ASEAN region road context, and the accidents scenarios involving the motorcyclists. It has been based on the following studies and reports.

Table 1: List of the selected article for WP1 literature review

Title	Journal/Conference	Year/Country
Motorcycle accident causation and identification of countermeasures in Thailand, Volume 1: Bangkok study	Final report, September 2001	2001/Thailand
An analysis of motorcycle injury and vehicle damage severity using ordered probit models	Journal of Safety Research	2002/Singapore
The patterns of traffic accidents in Thailand	ESAR Conference Proceeding	2004/Thailand
Crashes with roadside objects along motorcycle lanes in Malaysia	International Journal of Crashworthiness	2008/Malaysia
Motorcycle fatalities in Malaysia	International Association of Transport and Safety Sciences	2012/Malaysia
Identifying contributing factors to fatal and serious injury motorcycle collisions involving children in Malaysia	AAAM Conference Proceeding	2013/Malaysia
Commuter motorcycle crashes in Malaysia: An understanding of risks factors	AAAM Conference Proceeding	2013/Malaysia
Safety System for Child Pillion Riders of Underbone Motorcycles in Malaysia	Traffic Injury Prevention	2014/Malaysia
Fatal motorcycle crashes: a growing public health problem in Cambodia	International Journal of Injury Control and Safety Promotion	2015/Cambodia
Injury Pattern among Motorcyclists involved in Traffic Crashes	IRCOBI Conference Proceeding	2015/Malaysia
ASEAN Regional Road Safety Strategy	Association of Southeast Asian Nations (ASEAN) Report	2016/ASEAN

The first point to be highlighted is that detailed and/or reliable data are complicated to get within the ASEAN countries. Some data are missing for some ASEAN countries: Brunei Darussalam, Indonesia, Laos PDR, Myanmar, and Philippines. Therefore, most of the results and the more detailed one from the accident data study are based on Thai and Malaysian studies.

From the existing studies some relevant information have been gathered about the kind of accident involving a passenger car and a motorcycle:

- **Angular and side impact scenarios** appear to be the most important crash configuration in KSI motorcycle accidents in Thailand and Malaysia.
- **Rear-end collision** is the most frequent crash scenario in Bangkok according to an in-depth analysis of all injury severity motorcycle accidents. The second crash scenario involves **a motorcycle facing a vehicle turning, overtaking or driving in the motorcycle lane**.
- In the Thailand insurance database, angular scenarios include on the other hand, the cases where the other **vehicle comes in the path of the motorcycle** and the opposite cases where the **motorcycle rides on the lane of the opposite vehicle**.
- In Cambodia, **head-on and right-angle/side-swipe** account for about the same proportion of accidents (36% and 37%).

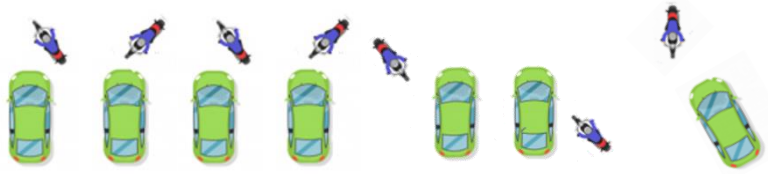


Figure 10: Interpretation of the main accident configuration identified within the literature review.

It also gives more information about the motorcycle riders and passengers. The results have been used for WP2 to characterize the motorcycles users (refer to 3.2).

In conclusion, the literature review has given relevant information about the overall ASEAN road traffic context and an overview of the accident context within the studied countries. However, it also shows the important to promote the registration of the accidents, as some countries shows either lack of information or reliability of the data.

Once the research about motorcyclists' accident and available databases in ASEAN region, the accident data study has been carried out to identify and describe the main accident situations. The inputs have also been compiled and analysed to provide the necessary information to the other Work Packages of the project. An analysis of the accidents between motorcycles and passenger cars in ASEAN countries has been conducted based on two datasets from Thailand and Malaysia.

The Malaysian accidents database is owned by Traffic Enforcement and Investigation Department of the Royal Malaysian Police and provided by MIROS (Malaysian Institute of Road Safety Research). This database is completed by the Police forces who gather all injury accidents across Malaysia and constitute the national accident database of Malaysia.

Country	Owner of the database	Provider of the data
		

It is gathering 3 years of data (2016-2018) with 5377 accidents with passenger cars, 1160 accidents involving a motorcycle. The information data concerning the vehicles are registered only if there is one injured occupant in the vehicle. This database is constituted of 91 variables distributed over three tables linked together by a unique number attributed to each accident. The three tables are described in the following section:

- A table with general information related to the accident: date, hour, number of vehicles involved, localisation, severity of the accident.
- A table with the driver information related to the drivers involved in the accidents. It describes the gender and the age of the driver, the status of his driving licence, the usage of a protective device, the driver errors, and the part of the body injured. It also includes data on the type of vehicle, the damage on the vehicle and the manoeuvre of the driver.
- A table with the injury information related to the injured occupants or pedestrians (not related to the driver: driver injury information is specified in the above-described table). The table describes the age and sex of injured occupants, the use of the seat belt, the position in the vehicle, the level of injuries, the part of the body injured and action of the pedestrian.

The Thai database provided is an on-the-spot accidents study managed by Honda and Yamaha. It is carried out in different region of Thailand with an in-depth protocol.
Sixteen provinces are covered by the study. This database is constituted of accidents where at least one motorcycle was involved. The opposite vehicle can be a passenger car, a lorry, a LGV (Light Goods Vehicle), or a pedestrian. The database also registers single motorcycle accidents.

Country	Owner of the database	Provider of the data
	HONDA	YAMAHA Revs Your Heart

The Thai database includes a relatively high number of severe accidents. About 30% of the accidents in this database resulted with at least one severely or one fatally injured occupant (KSI accidents).
The database is constituted of accidents which occurred from 2016 to 2020. The database is constituted of 751 motorcycle accidents, 639 of them occurring against one passenger car or one pick-up.

There are more than 20 tables in the database, each table dealing with a specific topic of motorcycle accidents. Each accident is described with around 700 variables.

At firstly, the method defined to compile and analyse the information from two different databases was to use a clustering method. This method provides groups of accidents (clusters) which contains accidents with comparable characteristics. Statistical indicators would then help to choose the most adequate clustering. However, this method could not be applied due to missing information about passenger car's manoeuvre for most of the accidents from the Malaysian database. Then, the method applied for the analysis is to characterise the accident scenario by crossing three parameters: collision type, motorcycle damage and manoeuvre.

Six main categories of situations have been identified as the most frequent motorcycle accident scenarios in both countries: *head-on, angular with frontal impact on the motorcycle, angular with lateral impact on the motorcycle, read-end accidents*, *angular with the motorcycle turning, right-angle (crossing), side-swipe*.

These situations are defined as in Table 2.

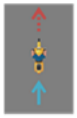
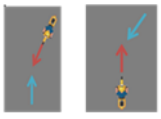
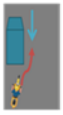
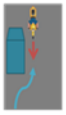
Table 2: Scenario constitution and coverage

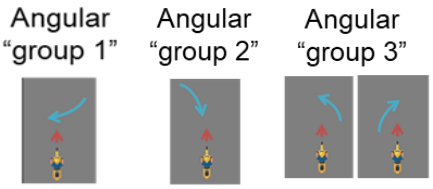
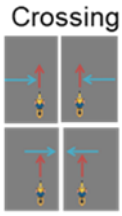
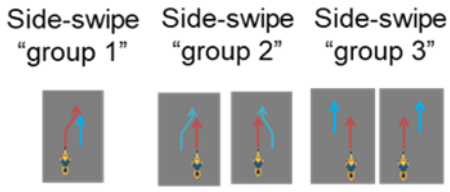
OASIM accident scenarios	Type of collision	Impact on the motorcycle	Manoeuvre of the motorcycle	% KSI Malaysian data	% KSI Thai data
Rear-end	Rear-end	MC – Rear Car - Front	▪ Same direction	5%	9%
Head-on	Head-on	Front	▪ Opposite	36%	19%
Angular with frontal impact on the motorcycle	Angular	Front	▪ Forward/other (Malaysia) ▪ Forward same direction/ opposite direction (Thailand)	15%	20%
Angular with lateral impact on the motorcycle	Angular	Lateral	▪ Forward/other (Malaysia) ▪ Forward same direction/ opposite direction (Thailand)	4%	9%
Angular with motorcycle turning	Angular	Lateral/Frontal	▪ Motorcycle turning	6%	13%
Right-angle (crossing)	Lateral 90°	Lateral/Frontal	▪ Perpendicular direction	5%	7%
Side-swipe	Lateral for both	Lateral	▪ Same direction	7%	6%
Total Coverage				78%	83%

The table below illustrate the scenario configurations.

Note: Accident scenarios, angular with frontal and lateral impact are considered together in the following clusters.

Table 3: OASIM sub-scenarios clusters

Accident Scenarios	Sub-scenario clusters
Rear-end	Rear-end 
Head-on	Head-on "group 1"  Head-on "group 2"  Head-on "group 3" 

Angular	
Angular with motorcycle turning right	
Crossing	
Side-swipe	

Among the twelve car-to-motorcycle accidents sub-scenarios identified, around one quarter is represented by **Angular scenarios with the motorcycle going straight**. The most critical sub-scenarios within these accident situations are the Car Turning Right Across the Path of the Motorcycle (14.8% of KSI from Thai database), followed by the Car turning Right or Left Across the Path of the Motorcycle - same direction (3.4% of KSI), and Car Turning into the Path of the Motorcycle.

The next most frequent one is the **Read-end scenarios**, more than 60% of this scenario correspond to the motorcycle colliding with the car however this situation cannot be covered by ADAS systems on the car and is not further analysed. Therefore, Rear-end Car to Motorcycle with the motorcycle going slower is studied (6.6% of KSI).

The third most frequent scenario is represented by the **Head-on** situations. The most critical sub-scenario is Both Vehicle Coming Straight from Opposite Direction (3.6% KSI), followed by the Car doing a Lane Change, with the Motorcycle coming from Opposite Direction (3.1% KSI) and the similar reversed situation with the Motorcycle doing the Lane Change (3.1%).

Within the most represented accidents, two situations have been highlighted: loss of control accidents and rear-end collisions where the motorcycle collide with the rear of the passenger car. These situations have not been considered in the analysis as ADAS systems may not help to avoid or limit the consequences of the accidents.

That first step enabled to highlight the most frequent and critical car-to-motorcycle accidents. Data recorded for Malaysia provides less detailed information about the accident characteristics and vehicle manoeuvres. Then, the Thailand in-depth database provides lots

of details and was used to describe the accident situations within sub-scenarios by including the car manoeuvre.

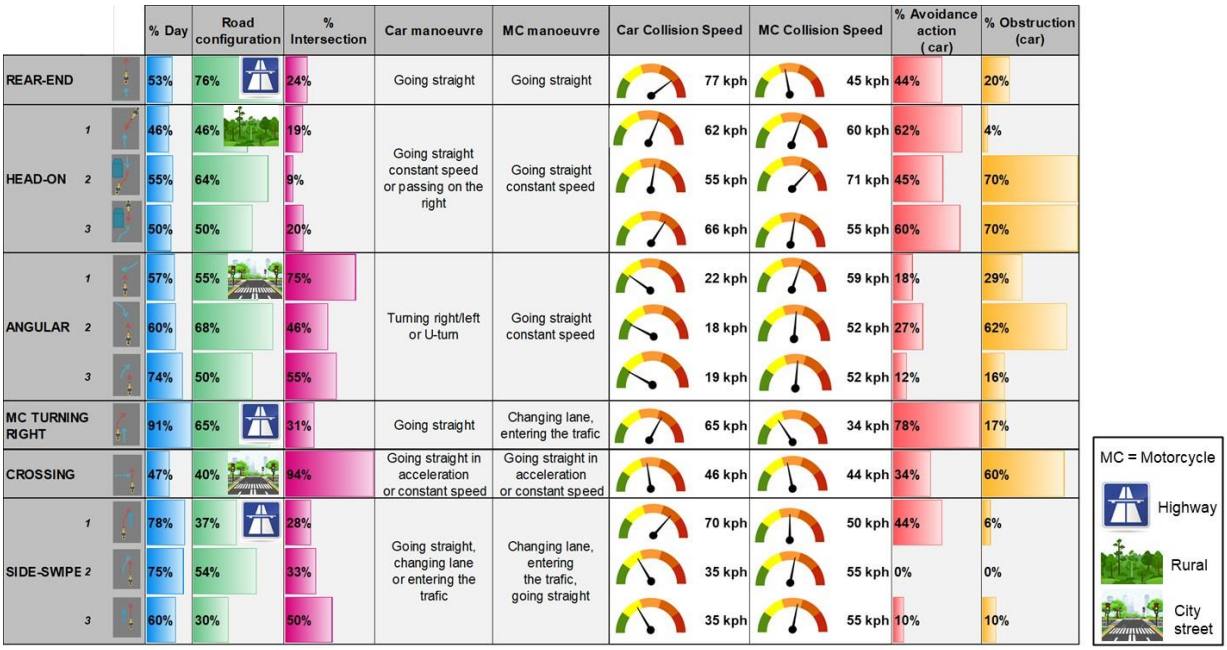
Therefore, the Thailand in-depth database was analysed to provide all the parameters of the sub-scenarios clusters. 24 parameters have been studied by sub-scenarios, classified in 3 categories: general conditions, road characteristics and vehicles characteristics.

Table 4: Variables studied by accident situation through the databases.

Accident characteristics – general conditions
Weather conditions
Light conditions
Road surface
Road characteristics
Location
Road category
Configuration (junction / roundabout / single carriage way)
Bend
Slope
Lane marking
Speed limit
Number of lanes
Travelled lane
Accident characteristics – vehicles
Visibility
Impact angle
Motorcycle impact type
Car impact type
Initial speeds
Collision speeds
Delta initial velocity
Skid marks
ABS fitment on the car
Motorcycle manoeuvre before crash
Action before crash (braking / avoidance)

Regarding the overall description of the accident scenarios from the two databases, it seems that the characteristics of the accidents are similar, except for the location. In Malaysia, most of the accident scenarios analysed occur in rural area, whereas the proportion of accidents happening in urban or suburban area is higher in the data collected in the Thai database. That may be related to the in-depth methodology, in which the investigators have to be close to the accidents to be sure to gather all the needed information, therefore accidents in rural area may be less reachable.

Most of the accidents happened with a clear weather and a dry road surface during the day. It shows the importance of developing ADAS systems to improve the safety of the motorcycle road users. In most of cases the visibility of the road user is clear, however obstructions appear to be significant in the crossing scenario and in the head-on scenario where either the car or the motorcycle is changing lane (passing by on the right). This analysis shows the diversity of the car and motorcycle impact speeds encountered in the different scenarios. The Rear-end scenario, Vehicles Coming Straight from Opposite Direction (head-on 1), Motorcycle merging toward the right in the lane of the car (side-swipe 1) scenarios are characterised by high car impact speed whereas the vehicles with turning manoeuvre exhibit the lowest velocity.



In summary, the WP1 accident data study has identified the most common and critical situations between a car and a motorcycle based on relevant data from Malaysia and Thailand. Those countries represent after Indonesia, the area with the most important number of cars registered, a fleet composed of half motorcycle. So, those two countries show a mixed traffic, relevant to highlight the different accident configurations between one car and one motorcycle. They provide the best compromise to have an overview of the most challenging car-to-motorcycle accidents configuration in the ASEAN region, taking into account the available data. All the detailed information for each sub-scenarios will be used in WP3 to define the relevant test scenarios to be able to evaluate the ADAS system within those accident configurations.

3.2 Motorcyclist target development

To be able to reproduce the accidents within test scenarios, a motorcyclist target has developed. The target is composed of a dummy representative of a motorcycle and a propulsion system to make to manoeuvre and go up to the speeds required. The first step was to characterise the most representative motorcycle of the ASEAN countries. Then once manufactured, the dummy must be fitted on the existing propulsion system to check the right integration of this new dummy to conduct the test within the requirements defined.

First the different kind of motorcycles encounter in the market are defined within Table 5.

Table 5: Definition of the different type of motorcycles encounter in the ASEAN market.

Scooter (SC)	Moped (MP)	Street (ST)	Sports (SP)
Scooter has a step-through frame and a platform for the rider's feet. Transmission is automatic.	Some mopeds have a step-through frame design, while others have motorcycle frame designs, including a backbone and a raised fuel tank, mounted directly between the saddle and the head tube.	Standards usually do not come with fairings or windscreens, or if they have them, they are relatively small. They are recognized primarily by their upright riding position.	Most sport bikes have fairings, often completely enclosing the engine, and windscreens that effectively deflect the air at very high speeds, or at least reduce overall drag.

The target must be representative of the motorcycles in the ASEAN region. Therefore, a study of the market has been carried out. The leader on the market is Honda, followed by Yamaha. Together they account for more than 80% of the motorcycles sold within Indonesia, Malaysia, Thailand, and Vietnam. However, they account for around 1% and the type of motorcycles seems to be different. For the following decision, it was decided to take Honda's and Yamaha's sales as reference to select the panel of the most representative motorcycles for the ASEAN region.

Figure 11: Honda's top sales within the ASEAN region (2017-2019)

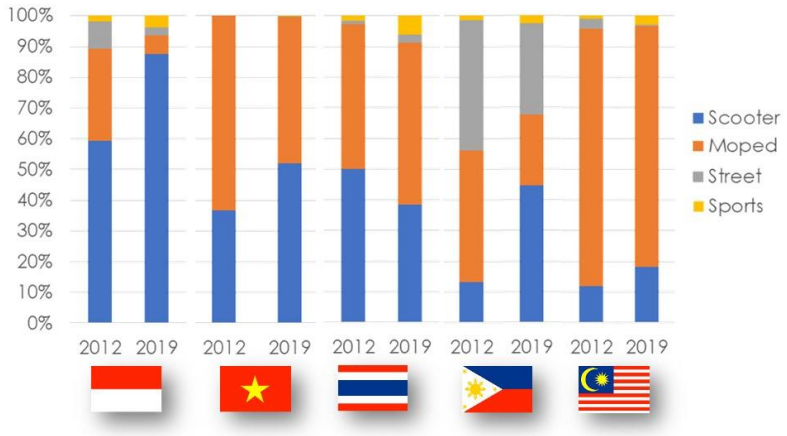
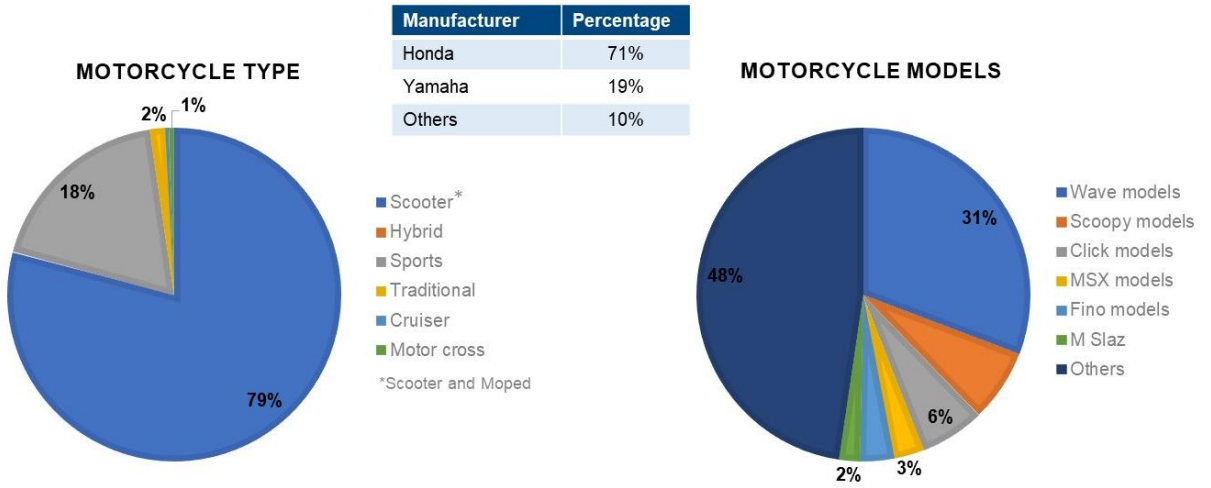


Figure 12: Yamaha's sales from 2012-2019

Looking at the information from the Thailand in-depth database of the accidents between a motorcycle and a passenger car, the main type of motorcycle involved in the accidents are mostly scooter type and the main models are Waves, Scoopy and Click models. Then sports kind of motorcycles are involved in 18% of the accidents observed.



Manufacturer	Percentage
Honda	71%
Yamaha	19%
Others	10%

Figure 13: Motorcycle type involved in accidents based on the Thai database (640 cases from 2016-2019).

Wave - HONDA	Click- HONDA	Scoopy - HONDA	MSX - HONDA	Fino - YAMAHA
				

The target must fit the detection of the real motorcycles and must be representative of the ones specific to the ASEAN countries. Therefore, to be accurate, it has been defined that the boundaries to evaluate the dummy should be determined by the measurements on a panel of four motorcycles, mostly represented within the vehicle fleets. To identify the motorcycles to select, the weighted factors were car registrations, motorcycles registrations, forecast for 2026 on these two items, the fleet proportion, and fatalities. The most relevant countries to consider are in order Thailand, Indonesia, Malaysia, Vietnam and Philippines.

Based on HONDA and YAMAHA sales from 2017-2019 and weighted on those countries, to panel to consider is as below.

*Model: **BEAT***
Type: scooter
Engine: 110cc

*Model: **SCOOPY***
Type: scooter
Engine: 110 cc

*Model: **VARIO***
Type: scooter
Engine: 125cc

*Model: **WAVE***
Type: moped
Engine: 100,110,125cc

Figure 14: Selected four motorcycles representatives of the ASEAN region

The dummy is composed of two parts: the motorcycle and the rider(s). In order to characterize the rider, the information from the literature review and the databases study have been used as basis.

In some numbers about the rider and passengers of the motorcycles among the fatalities, the proportions are:

- Malaysia (2005-2009): 89% riders, 11% passengers
- Cambodia: 76% riders, 24% passengers
- Thailand (2014-2015): 80% riders, 20% passengers

The conclusions on the gender and the age of the powered-two wheelers in ASEAN countries are:

The proportion of crash with passengers observed from the data are:

- One third of the accident with motorcyclists in Bangkok (Thailand) involved a rider and a passenger.
- Within the motorcycle's accidents with passengers, 94% happened with one passenger, 6% more than one passenger (based on Malaysia 2013-2015 Insurance company)

With a closer look in Malaysia, 11.5% of the motorcycle crashes involved a child (rider or passenger) under 16 years old within 26% showed more than two children.

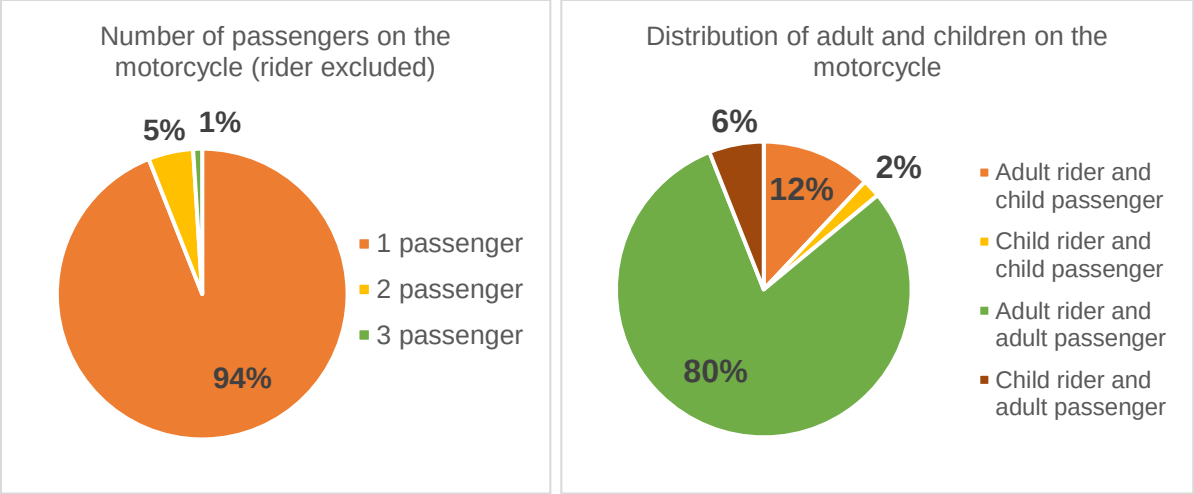


Figure 15: Malaysian accident data (2014+2015 accidents) - Analysis of 171 pairs of riders/passengers

In conclusion, it was decided to not consider the passengers for the motorcyclist target as they represent 11% to 24% within the countries observed.

For the rider dimension, a literature review has been carried out on 5 main sources.

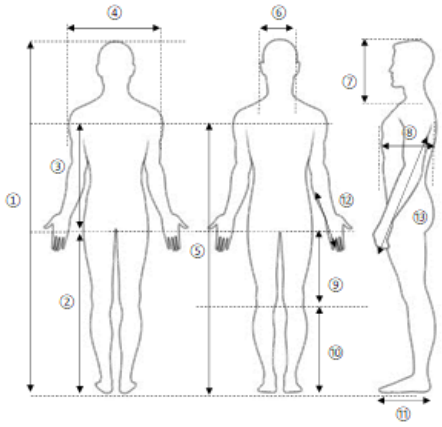
Sources	Titles	Countries	Details
#1	Anthropometric measurements among four Asian countries in designing sitting and standing workstations	Malaysian, Indonesian, Philippines, Thailand	Malaysian operator: 146 (18-45 years old) Indonesia: 245 (18-45 years old) / Thailand: 200
#2	A century of trends in adult human height	ASEAN	
#3	Incorporating Malaysian's Population Anthropometry Data in	Malaysia	Anthropometric data of 795 male subjects

	the Design of an Ergonomic Driver's Seat		
#4	Anthropometric study among adults of different ethnicity in Malaysia	Malaysia	Anthropometric data for Malays aged 18 to 24 years (n=50)
#5	Anthropometric Data of ASEAN Adults and Children for ASEAN NCAP	Indonesia, Thailand and Malaysia	Anthropometric data of 376 male subjects (Malaysian: 130, Thai: 121, Indonesian: 125)

Based on the mean values found with the different sources, the dimensions representative of the ASEAN motorcyclist are the ones represented in the table.

Additional studies on the dimensions of Chinese population have been carried out during the development of the C-NCAP STA (Scooter Target Asia) defining a target for e-scooters. Since comparison of rider dimensions show high similarity, the rider of the existing target was used for harmonisation.

N°	Dimensions	*MEAN*	*AMT V1.0*	*Deviation [%]*
1	Body Height	*170.99*	*165.00*	*-3.63*
2	Waist height	*98.20*		
	Height - Sitting Height	*82.32*	*82.00*	*-0.39*
3	Upper body length	*53.69*	*53.00*	*-1.30*
4	Shoulder width	*44.16*	*43.00*	*-2.69*
5	Shoulder height	*143.88*	*138.00*	*-4.26*
6	Head width	*16.53*	*15.90*	*-3.98*
7	Head height	*18.66*	*20.00*	*6.70*
8	Chest depth	*18.91*	*21.00*	*9.95*
9	Upper leg length	*56.07*	*57.00*	*1.63*
10	Lower leg length	*42.69*	*42.00*	*-1.63*
11	Foot length	*26.08*	*25.00*	*-4.31*
12	Arm reach forwards	*78.15*		
13	Elbow grip length	*35.33*	*36.00*	*1.86*



From theses conclusion on the representatives' motorcycles and riders within the ASEAN countries. Measurements with current sensors used of ADAS systems have been done with the real objects and the dummy versions.

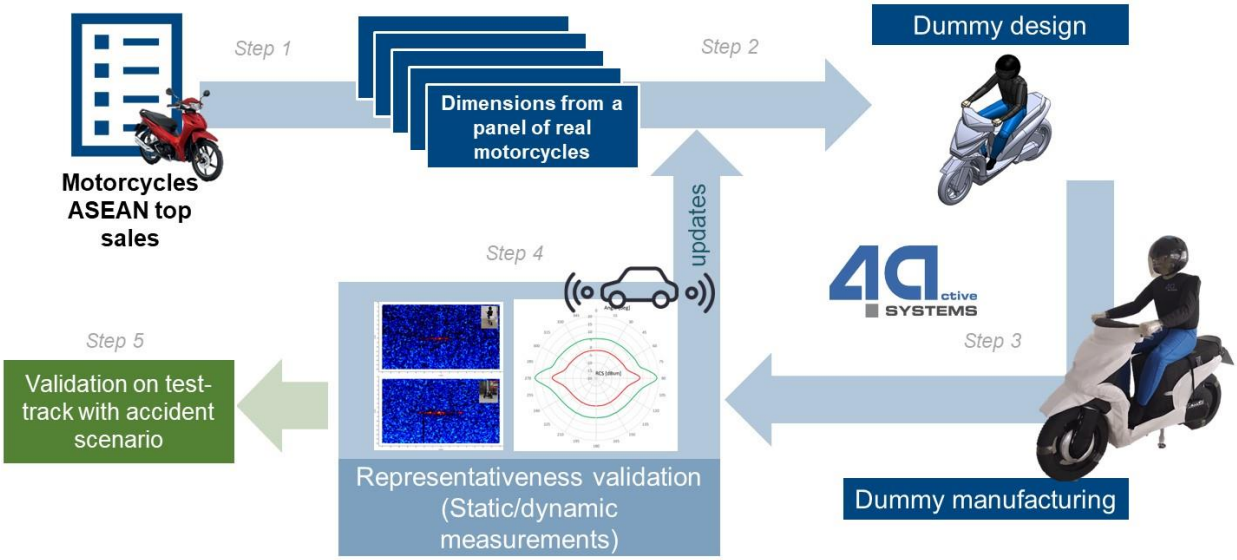


Figure 16: Development process for the motorcyclist dummy.

Finally, all the specifications are described in the deliverable D2.1 [7].

Figure 17: Motorcyclist dummy versions

Figure 18 Scooter rider and scooter target

3.3 Test and Assessment protocol

The aim for the next ASEAN NCAP protocol is to be the most challenging assessment for ADAS systems applied to accidents with motorcycles among NCAPs. The amount of powered-two-wheelers in the ASEAN countries makes it a priority to develop the tools helping the automotive industry to implement such systems. To be able to address the maximum of the critical accidents and due to limitations (road condition, test feasibility, technological feasibility), the proposal is to proceed step by step and to update the protocol along with the ASEAN NCAP assessment update.

The proposal of roadmap is as below and detailed in the following part of this report.

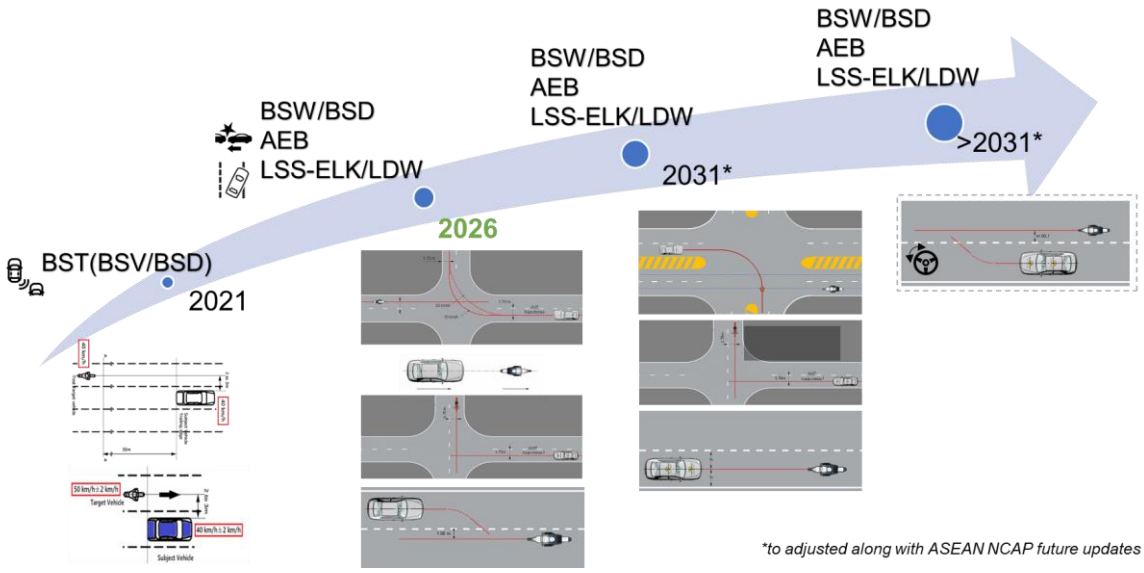


Figure 19: OASIM Final proposal for ASEAN NCAP Motorcyclist Assessment Roadmap

The current protocol with motorcyclist integrated in 2021 introduce a first scenarios evaluating Blind Spot Technologies with three tests:

- Target vehicle entering the 30 meters zone with a steady speed
- Target vehicle overtaking the Subject Vehicle speed
- False warning

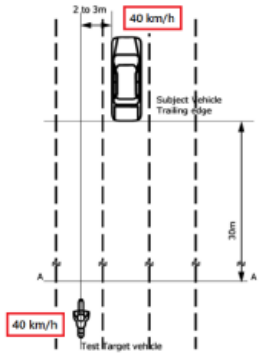
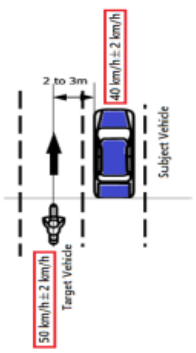
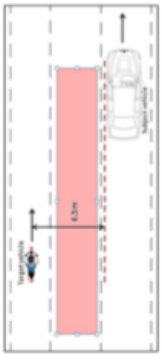
Target vehicle entering the 30 meter zone with steady speed	Target Vehicle overtaking Subject Vehicle speed	False warning test
		

Figure 20: Test scenarios within the ASEAN NCAP Assessment 2021.

The accidents situations expected to be addressable by the ADAS systems by 2026 have been identified within the 12 most relevant accidents scenarios based on the accident data study (WP1). These accidents situations and their detailed have been discussed to identify the situation that can be address by ADAS technologies and are feasible in terms of testing.

The situation has been then classified in four categories. Priority n°1 is the scenarios addressable by the ADAS systems within the timeline for 2026. Priority n°2 are more complicated scenarios that needs new ADAS technologies and development, could be feasible after 2026. Priority n°3 are representing feasible scenarios however with lower criticality and partly cover with current Blind Spot Technologies already assessed in 2021. Finally, the last category gathers the other scenarios, complicated to address within 2026 - 2031 timeline, however the situations could be reviewed in the future with more experience.

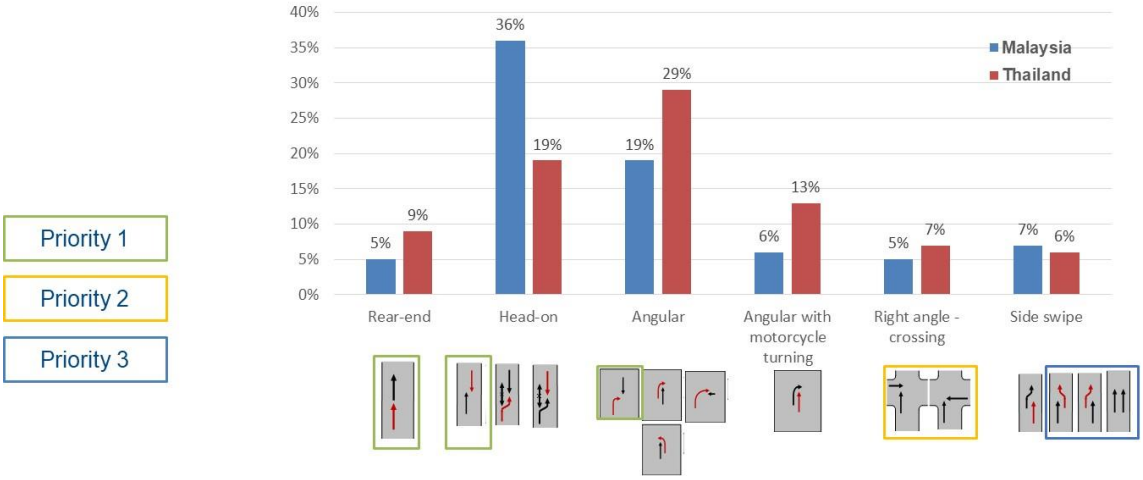


Figure 21: Main accident scenarios - datasets from Malaysia and Thailand

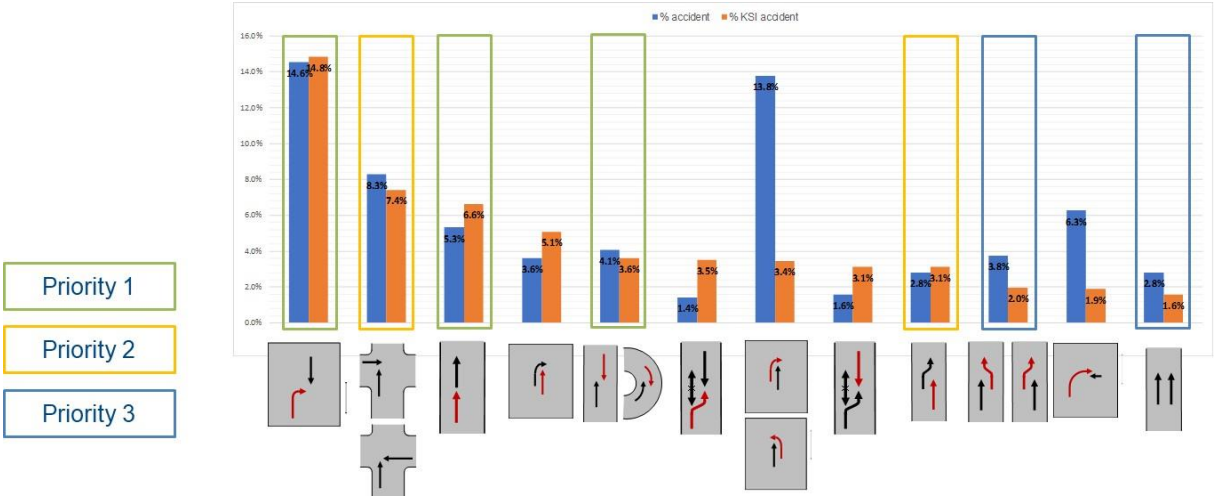


Figure 22: Main accident scenarios - datasets Thailand

Priority 1 have been defined in four test scenarios based on the details from the Malaysian and Thai databases. It allows to cover around 30% of the accidents between a motorcycle and a passenger car.

Table 6: Representativity of the four accident scenarios to be covered by next assessement in 2026.

%/all accidents	14.6%	8.3%	3.6%	4.1%
% KSI	14.8%	7.4%	5.3%	3.6%

Pictogram	1	2	3	4

For the next update, expected in 2026, OASIM identified 4 test scenarios, evaluating Autonomous Emergency Braking (AEB), Forward Collision Warning (FCW), and Lane Support Systems (LSS):

- Car to Motorcycle Rear-end moving (CMRm) [FCW - AEB]

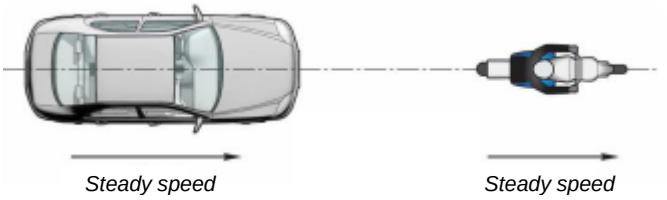


Figure 23: CMRm test scenario

Based on the accident data study, the most represented configuration is accidents with the motorcycle at constant and slower speeds for the motorcycles. The main impact point is the middle of the vehicle front bumper with the rear of the motorcycle. The systems expected to be active is an active braking (AEB). However, it is also suggested to test the configuration with a lower overlap on the front bumper (25%) to cover more accident. The most relevant action is warning (FCW) to limit the fault positive within the ASEAN road traffic. The driver can then brake or do a steering avoidance.

- Car to Motorcycle Front Turn Across Path (CMFTap) [AEB]

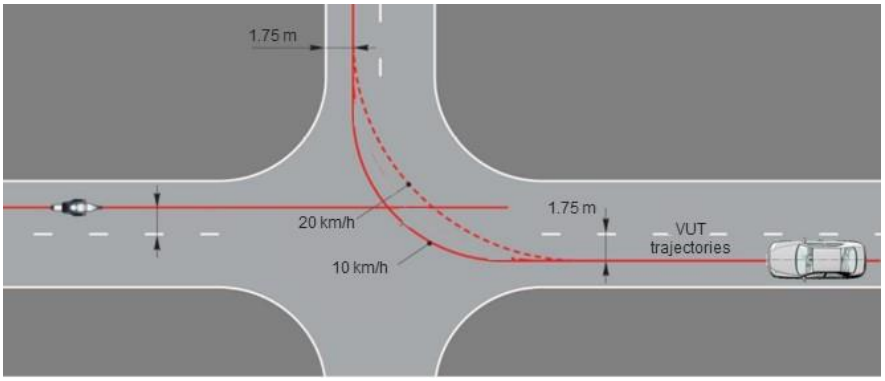


Figure 24: CMFtap test scenario

This scenario is the most critical looking at the accident cases observed. The parameters have been based on the experience from Euro NCAP [8], as the dimension of the intersections are relevant with the ones observed in Europe. One of the main configurations that cannot be covered is turning manoeuvre at higher speed (30 km/h) and wider intersection dimensions [9]. The expected and assessed reaction from the system is an active braking (AEB) to avoid the collision.

- Car-to-Motorcycle Crossing (CMCrossing) [AEB]

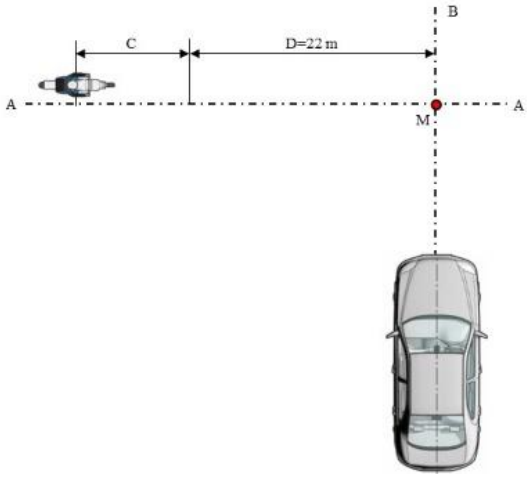


Figure 25: CMCrossing test scenario

From the accident data study, most of the cases shows higher speed than 20 km/h for the motorcycle, with mean values for initial speeds and collision speeds between 40 and 50km/h. In terms of technological feasibility, the lowest speeds of AMT can be handled with conventional front sensing field of view. However, covering situations with higher speed of AMT mandates wider sensing field of view (with corner radar for example). Therefore, it was decided to integrate the situation at the lowest speed for the motorcycle as a first step in 2026 to address this accident situation. The impact point, according to the data, to be tested are, with the motorcycle coming from the right or left side, the middle of the car front bumper collides with the middle side of the motorcycle.

- Car-to-Motorcycle Oncoming (CMOncoming) [LSS – LDW/ELK]

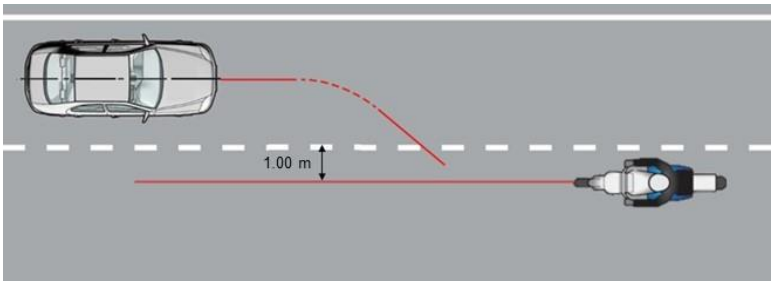


Figure 26: CMOncoming test scenario

The system to be assessed in that situation is a lane support system (LSS) as the vehicle is lead out of its lane with the motorcycle's. It was highlighted by the discussion that the heavy traffic and road condition may not allow a safe steering action from an ADAS system. Then the market may not be ready to integrate an active steering function. One requirement for the car is to have EPS (Electric Power Steering Control). In overall the system is not common on the market (only some OEMs) however it tends to increase in the market for the upcoming years.

Therefore, two options are suggested for the assessment. In case the technology for ELK action is realistic for 2026, the pass/fail criteria will be the collision with the target. Otherwise, an emergency warning could help in that situation to alert the driver that the vehicle drift over its travelling lane and a motorcycle is coming from the opposite direction.

The corresponding parameters for the test are summarized in Table 7:

Table 7: Test scenarios parameters based on the OASIM proposal for ASEAN NCAP Assessment 2026.

	CMRm		CMFtap	CMCrossing	CMOncoming
Paragraph	8.3.1		8.2.2	8.2.3	8.2.6
Type of test	AEB	FCW	AEB	AEB	LSS
VUT Speed [km/h]	40-60	40-80	(2026) 10,20	20-60	72
VUT direction	Forward		Farside turn	Farside and nearside	Farside
Target speed [km/h]	30,45,60		30,45,60	20	60
Impact location [%VUT width]	50	50 and 25	50	50 -50% motorcycle length	10
Lighting condition	Day		Day	Day	Day
Number of test	36 speed combinations (best case: 22 tests)		6 tests	9 speed combinations (best case: 5 tests)	4 – 5 tests

For the upcoming updates of the assessment after 2026, currently to be expected for 2031, it would be suggested to add relevant updates on the 2026 test scenarios. These recommendations are taking into consideration the need of further study and first experience.

- CMFTap with an additional speed for the vehicle under test: 30km/h
- CMCrossing with obstructions and higher speed for the target.
- Add the Car-to-Motorcycle Head-on test scenario.

The last part of this roadmap refers to the other accidents situations, that cannot be covered within this timeline, however they are still relevant situation that should stay under consideration and may be addressed later in time with new ADAS technologies and test experience. It also entailed ADAS technologies, such as a steering action, for which the ASEAN market is not ready yet, as the integration within the specific ASEAN countries traffic should be studied.

Conclusion

This report summarizes the Work Packages results from the accident cases observations to the final OASIM proposal for the next ASEAN NCAP Assessment for Motorcyclist safety in 2026. The first work package enables to identify twelve most common and critical accidents situations, based on the databases studies. This analysis gave the inputs to the third work package to select the relevant test scenarios to address with ADAS systems, and to define the variables to reproduce them on the test track. The tools to carry out the test scenarios also implied the development of a motorcyclist target due to the risk of impact and the need of accuracy and repeatability within the tests for all the vehicles. Therefore, one outcome of the project is the new motorcyclist target – the ASEAN NCAP Motorcyclist Target – representative of the most common powered-two-wheeled used in the ASEAN countries.

Finally, the synthesis of the discussions on the accidents specifications, the ADAS technologies and the testing feasibility pointed out 4 relevant test scenarios to assess AEB and LSS systems for the next ASEAN NCAP assessment: Car-to-Motorcycle Rear-end moving, Car-to-Motorcycle Front turn across path, Car-to-Motorcycle Crossing, Car-to-Motorcycle Oncoming.

This proposal is a first steps to improve the assessment for motorcyclist safety. The ambition is to have the most challenging proposal, regarding the critical context of the motorcyclist fatalities in the ASEAN region. Recommendation have been identified and a roadmap has been defined by the project to help the next steps of ASEAN NCAP assessment towards this goal.

To improve the motorcyclist safety on the ASEAN roads, other topics could be studied such as the Advanced Rider Assistance Systems (ARAS), and the light and weather conditions. Active systems to be integrated on the motorcycles could help cover more accidents, some studies have already been done on the potential of ABS systems. However, this aspect is still subject to an economic aspect and the feasible systems to be implemented in the motorcycle must be affordable with the price of the vehicle. Then, even though most accident observed within the databases in the project shows that most accidents happened during the day and without rains. Depending on the type of accident a relevant number of cases happened at night and the weather in the ASEAN countries can present heavy rains during some time of the year. Therefore, these conditions to test the feasible performance of the ADAS systems could be also studied.

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